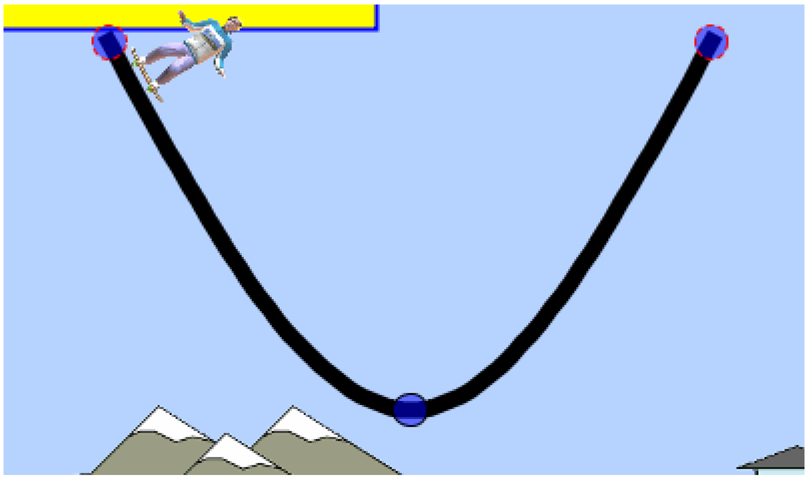
PHET – Energy Skate Park

Purpose – The purpose of the energy skate park simulation is to see how energy gets transferred in a real world application. In this simulation you will manipulate the skater, friction, gravity, and other factors to see the affect of these on a skater who behaves according to the laws of physics.

Energy Transfer without Friction – Make a prediction 1st!

You have already learned that in a frictionless, or air resistance less world, that potential and kinetic energy are readily exchanged in a mechanical system and total energy is conserved. For each graph below, draw the expected potential, kinetic, and total energy of a skater going down a curved track, then back up the other side, with no friction. Show multiple (at least 3 cycles)

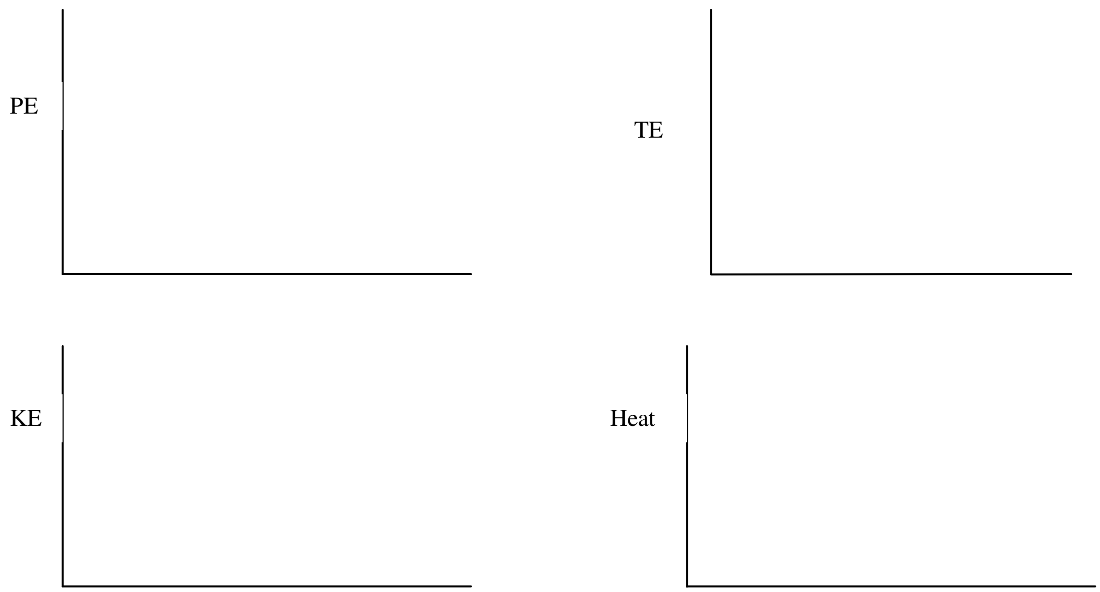


PE

TE

KE

With Friction – Now in an environment with friction, some of the energy is lost as heat. For each graph below, draw the expected potential, kinetic, and total energy of a skater going down a curved track then back up the curved track, with some small amount of friction. Show multiple (at least 3 cycles). In addition there is a graph of total heat (not instantaneous heat). Make a prediction of what a graph of this would look like too.

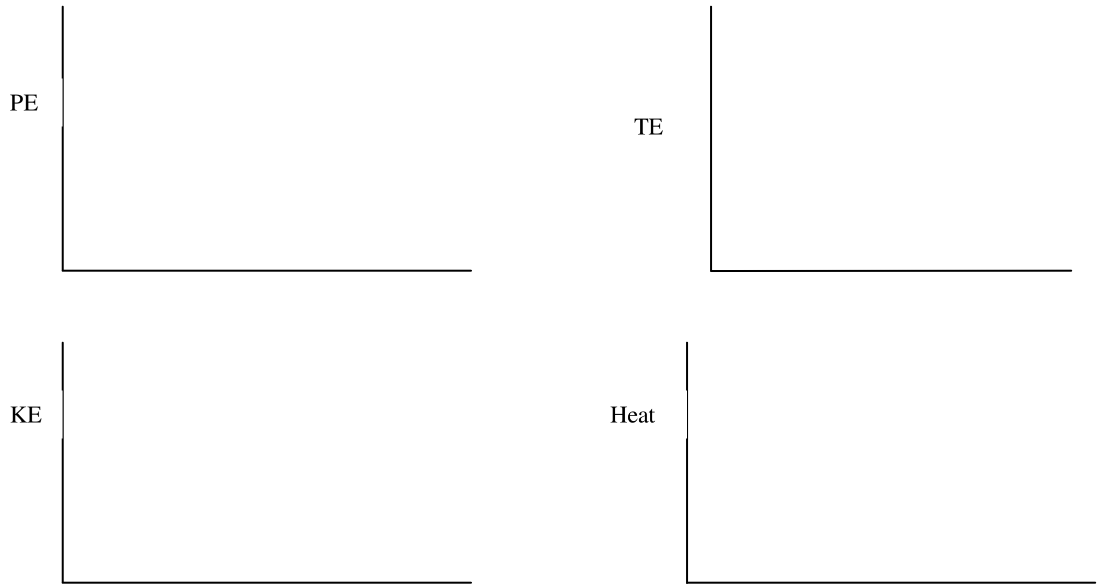


SIMULUATION TIME –

Now go back and simulate the motion both without (top set of graphs) and with friction (bottom set of graphs), and mark on the graph the actual energy as measured in the simulation. Even if you got it right, go back and mark (in another color) the actual shape.

Affect of gravity

On the graphs below, show the difference you might expect if you put the skater on Jupiter, where gravity is approximately 2.65x that of Earth. Label the graphs in terms of the PE, KE, and TE of the Earth graphs above. Remove Friction again!



SIMULATION TIME –

Now go back and simulate the motion as if on Jupiter, and without friction, and mark on the graph the actual energy as measured in the simulation. Even if you got it right, go back and mark (in another color) the actual shape. What would the graph of heat look like?

Affect of Gravity Part II – Now you are going to speculate as to what happens if there is no gravity. Or more importantly, how to simulate gravity when there is none. Set the skater on the end of the track with the gravity of "Space" selected. You will note that he does not move. If you use the arrow keys you can get the skater to move. If you push the down arrow the skater will go down. But the fire from the rocket is going up. Which of Newton's laws ensures this is what happens?

Affect of Gravity Part II continued – You have been told that weight is nothing more than a force, but that it is impossible to distinguish this from an accelerating frame of reference. If you accelerate the skater down, does he behave exactly the same as he does in a gravitational field? Try it, and explain what you observer. Why do you think the simulation behaves this way?

The writers of this software show that PE is zero in space (far from anywhere). Does this make any sense, why is it not infinite ($mg * h = mg*\infty$)? Hint: They are correct on this one, what does gravitational potential mean really?

JFF – Just for fun

1. See if you can have the skater do two loops

2. See if you can have the skater go airborne, but land on another track

3. See if you can have the skater say cow-a-bunga.

Reset to the original track and conditions.

Keeping the track THE SAME, open up whichever plot you prefer to best view the AMOUNTS of energy there are at each moment in the simulation. Now, play the simulation, pausing occasionally to see how much of each energy form exists at different points along the track. Locate the point(s) on the track where the skater has THE MOST potential energy.

1. Where does the skater have the greatest amount of potential energy? (Describe in words or with a diagram.)

Now, change as many features of the simulation as you can in hopes of finding ALL the factors that affect how much potential energy the skater has at the point(s) you described in question 1.

2. What changes did you make that caused the potential energy at that point to INCREASE?

3. How does the maximum kinetic energy that the skater acquires compare with the potential energy you found in #2?

4. Are there any other factors you can change that will cause the maximum kinetic energy to INCREASE? What are these, if any?

Now reset the simulation to the original track and conditions, and pause your skater at the very top of his motion. Set friction to some value OTHER THAN zero and ask to view the energy vs. time and bar graph options. Let the skater skate for awhile and observe what happens to the motion.

5. Describe what is happening to the various forms of energy as time goes by.

6. Record the potential, kinetic and thermal energy values the skater had at the very beginning of his motion.

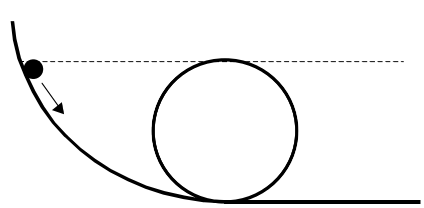
7. Allow the skater to continue until he comes to rest and record the potential, kinetic, and thermal energy values he has there.

8. What do you notice about the values you've recorded in questions 6 and 7?

9. The main difference between kinetic energy, KE, and gravitational potential energy, PE_g, is that
   a. KE depends on position and PE_g depends on motion
   b. KE depends on motion and PE_g depends on position.
   c. Although both energies depend motion, only KE depends on position
   d. Although both energies depend position, only PE_g depends on motion

10. As an object free falls, the gravitational potential energy
    a. vanishes
    b. is immediately converted to kinetic energy
    c. is converted into kinetic energy gradually until it reaches the ground

11. A small mass, starting at rest, slides without friction down a rail to a loop-de-loop as shown. The maximum height of the loop is the same as the initial height of the mass. Will the ball make it to the top of the loop?



a. Yes, the ball will make it to the top of the loop. b. No, the ball will not make it to the top.

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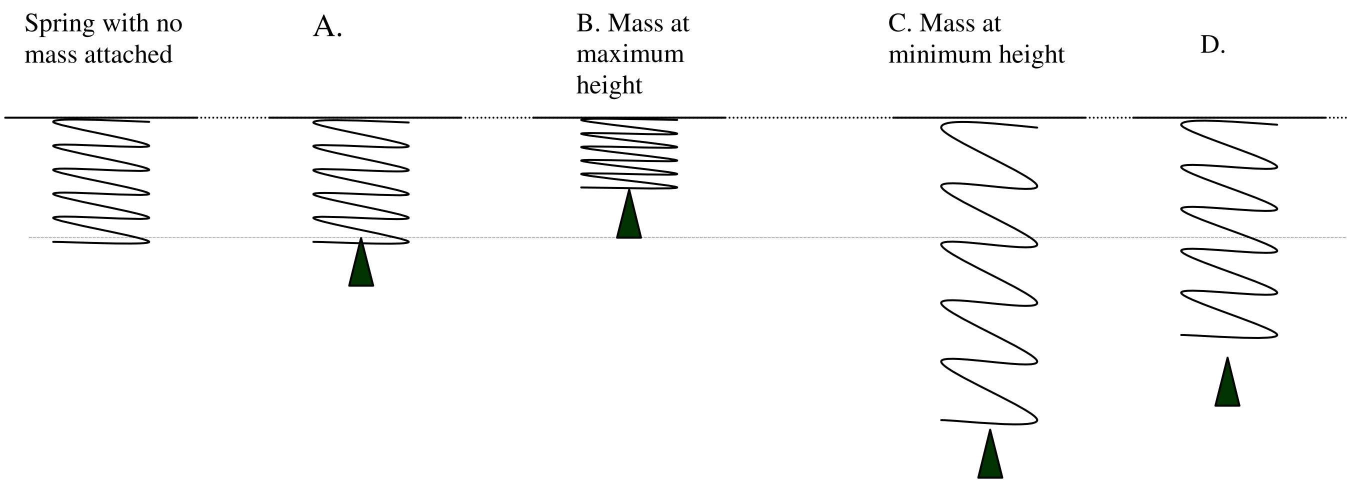
Use the figures below to answer 5-7. A spring is hanging from a fixed wire as in the first picture on the left. Then a mass is hung on the spring and allowed to oscillate freely (with no friction present). Answers A-D show different positions of the mass as it was oscillating. The dotted lines are on the drawing to help you see the change in position relative to the spring with no mass.



For each of the questions, select <u>all</u> the letters that apply.

6. Where is the gravitational potential energy the least?

7. Where is the kinetic energy zero?

8. Where is the elastic potential energy zero?